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MEDICAL RESEARCH COMMITTEE.

REPORTS

OF THE

CHEMICAL WARFARE MEDICAL COMMITTEE.

No. 16.—REPORT ON THE LENGTH OF STAY IN HOSPITAL IN THE UNITED KINGDOM AND THE DISPOSAL OF GAS CASUALTIES.

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November, 1918.

In January, 1918, the Director-General, Army Medical Service, with the concurrence of the Controller of the Chemical Warfare Department, Ministry of Munitions, appointed a special Committee to prepare reports, based upon information received from all sources at the Chemical Warfare Department, for submission to him with a view to their distribution to those concerned, to make suggestions for further co-ordinated medical investigations that may seem desirable, and to advise him generally in respect of the scientific medical aspects of Chemical Warfare. Present constitution of Committee :—

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(With the co-operation of Lieut.-Colonel C. Gordon Douglas, M.C., M.D., R.A.M.C., and Colonel T. R. Elliott, D.S.O., M.D., F.R.S., in France, and of other corresponding members at Porton and in London, Edinburgh, France and Italy.)

REPORTS ALREADY ISSUED.

No. 1. Notes on the Pathology and Treatment of the Effects of Pulmonary Irritant Gases. (*March*, 1918.)

No. 2. The Histological Effects produced by Gas Poisoning and their Significance. (*April*, 1918.)

No. 3. The Symptoms and Treatment of the late Effects of Gas Poisoning. (*April*, 1918.)

No. 4. Polycythæmia after Gas Poisoning and the Effect of Oxygen Administration in the Treatment of Chronic Cases. (*April*, 1918.)

No. 5. The Reflex Restriction of Respiration after Gas Poisoning. (*April*, 1918.)

No. 6. Investigations into the Reaction of the Blood after Gas Poisoning, and the Results of the Administration of Saline and other Substances. The Effects of Bleeding and of the Injection of Calcium Chloride. (*April*, 1918.)

No. 7. Changes observed in the heart and circulation and the general After-Effects of Irritant Gas Poisoning. (*April*, 1918.)

No. 8. Reports on Fatal Cases of Poisoning. (i) Ethyl iodoacetate.

No. 9. Tissue Changes in Animals produced by Pulmonary Irritant Gases. (*September*, 1918.)

No. 10. The Administration of Oxygen in Irritant Gas Poisoning. (*October*, 1918.)

No. 11. Investigations of Chronic Cases of Gas Poisoning. (*October*, 1918.)

No. 12. Treatment of Patients suffering from "Effort Syndrome" by continuous inhalation of Oxygen. (*October*, 1918.)

No. 13. Bleeding after Poisoning by Pulmonary Irritant Gases, with Appendices. (*November*, 1918.)

No. 14. The Delayed Effects of Phosgene in Rabbits, with special Reference to the Influence of Muscular Contraction. (*November*, 1918.)

No. 15. The Later Effects of Irritant Gas Poisoning. (*November*, 1918.)

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REPORT ON THE LENGTH OF STAY IN HOSPITAL IN THE UNITED KINGDOM AND THE DISPOSAL OF GAS CASUALTIES.

(With Two Appendices.)

The present report is based upon the examination of 4,575 case cards (A.F. W.3243a). These cards refer to Gas casualties who were discharged from Primary Hospitals in the United Kingdom during the approximate period May 1st to August 1st, 1918.

The information obtained from the cards was mainly of a statistical character, and no attempt has been made to analyse the symptoms of those cases discharged from Primary Hospitals during the first nine weeks.

It was considered that a longer stay in Primary Hospital than nine weeks was unduly prolonged, and an attempt has been made to analyse the symptoms which necessitated a longer stay in Primary Hospital than this.

On consideration it appeared that too much delay would be caused by an attempt to trace the complete history of the 4,575 cases throughout their whole convalescence. In place of this, however, an appendix (No. 1) has been added, in which the complete hospital history of cases of Gas casualty from a Reserve Depôt has been traced.

Amongst the cards there were 67 cases of re-admission to Primary Hospital for symptoms directly referable to Gas Poisoning. It was considered of importance to analyse these symptoms, and the result of this analysis is embodied in Appendix 2.

In cases of death every effort has been made to obtain complete clinical and post-mortem reports to supplement the information contained in the cards.

I. Time in Hospital in France.

The period elapsing between the date of gassing and that of evacuation to the United Kingdom was ascertained in 1,455 cases (Table I). This table shows that 969 (67 per cent.) of these cases, are discharged from hospital within nine weeks of the time of gassing. Further facts can only be determined when comparison is made with a similar table compiled from cases which have been treated to a conclusion in hospitals in France. It must be borne in mind in regard to this and succeeding tables that the worst cases of Gas Poisoning which recover are included in those numbers which are evacuated to the United Kingdom, while the slighter cases are retained in France.

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TABLE I.

Time in Hospital in U.K.	Time in Hospital in France.																							Total number of cases.
	Days.														Weeks.									
Weeks.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	3	4	5	6	7	8	9	10	11	
1	—	—	—	—	2	—	2	—	—	1	—	—	—	—	4	2	1	—	—	—	—	—	—	12
2	—	—	—	—	6	9	6	5	13	4	9	2	5	6	5	5	4	3	—	2	1	1	—	86
3	1	—	1	4	10	9	3	8	12	11	7	10	4	1	12	7	1	5	2	—	—	—	1	109
4	—	—	1	5	9	11	11	15	10	8	13	8	9	7	20	5	2	2	—	—	—	—	—	136
5	—	1	5	12	22	13	23	13	11	18	8	12	6	10	30	6	2	1	—	1	—	—	—	194
6	2	2	2	20	16	28	22	21	4	8	10	14	9	11	31	12	—	2	—	1	—	—	—	215
7	—	2	1	10	22	25	32	34	13	16	7	9	12	4	26	5	1	1	1	—	—	—	—	221
8	—	—	1	13	17	10	17	19	7	9	4	9	10	3	21	5	2	3	4	—	—	—	—	154
9	—	1	—	5	9	4	7	13	10	5	5	10	7	6	15	4	3	1	—	—	—	—	—	105
10	1	1	—	5	11	5	4	5	5	3	2	4	5	1	8	—	—	2	—	1	—	—	—	63
11	—	—	1	3	1	3	4	5	1	6	1	3	4	1	6	2	1	1	—	—	—	—	—	43
12	1	—	3	2	6	2	2	2	1	4	2	8	4	1	8	1	2	2	—	—	—	—	—	51
13	—	—	1	1	4	2	1	3	2	—	—	3	—	1	—	1	—	—	—	—	—	—	—	19
14	—	—	—	1	1	—	2	1	—	—	1	—	—	1	1	—	—	—	1	—	—	—	—	9
15	—	—	1	—	2	—	—	1	—	2	—	2	—	—	3	—	—	—	1	—	—	—	—	12
16	—	—	—	—	—	—	1	—	3	—	1	—	1	—	2	—	1	—	—	—	—	—	—	9
17	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
18	—	—	—	—	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	3
Over 18	—	—	—	—	—	—	1	—	1	1	2	1	—	—	4	1	1	—	—	—	—	—	—	12
Total	5	7	17	81	139	121	138	146	94	96	72	95	76	53	198	56	21	23	9	5	1	1	1	1,455

II. TIME IN HOSPITAL IN UNITED KINGDOM, AND DISPOSAL.

Table II gives the duration of stay in, and disposal from, hospitals in the United Kingdom, of the 4,575 cases. The rate of discharge increases rapidly up to the 6th week and diminishes rapidly from this on. 1,285 cases (28·5 per cent.) are discharged direct to their Reserve Battalions, while 1,504 (33 per cent.) are sent to Command Depôts, and another 1,502 (33 per cent.) to Military Convalescent Hospitals. The last column in the table (Other Diseases) refers to those cases whose retention in hospital was apparently mainly due to conditions other than those directly attributable to Gas Poisoning.

TABLE II.—*Time in Hospital in United Kingdom, and Disposal.*

Weeks in Primary Hospital in U.K.	Disposal.								Total.
	Fur. I.	Fur. II.	M.C.H.	Other Hosp.	Fur. III.	Perm. Unfit.	Deaths.	Other Diseases.	
1	8	5	15	10	—	—	15	—	53
2	62	46	145	13	—	—	8	1	275
3	72	89	176	26	3	—	3	1	370
4	115	101	206	13	2	—	2	1	440
5	187	183	237	11	3	—	3	3	627
6	199	221	208	9	15	—	—	—	652
7	177	234	162	8	11	2	1	—	595
8	145	174	121	6	11	—	—	—	457
9	110	117	80	2	9	1	—	—	319
10	89	103	40	3	14	—	—	5	254
11	48	76	30	2	3	3	—	4	166
12	24	61	33	3	2	3	—	7	133
13	13	29	15	—	7	1	—	1	66
14	7	22	8	2	3	1	—	1	44
15	7	9	4	—	3	—	—	2	25
16	—	13	8	1	—	—	—	1	23
17	4	3	1	—	—	—	—	—	8
18	2	5	3	—	—	—	—	—	10
19	1	3	3	1	—	—	—	—	8
20	1	2	—	—	—	—	—	—	3
21	2	1	2	—	—	—	—	—	5
22	1	1	—	—	—	—	—	—	2
23	1	—	—	—	2	1	—	—	4
24	2	1	—	1	1	1	—	—	6
25	3	—	—	—	—	—	—	—	3
26	1	2	1	—	1	—	—	—	5
27	1	—	—	—	1	1	—	—	3
29	—	—	2	—	1	—	—	—	3
30	—	—	—	—	2	—	—	—	2
31	—	—	1	—	—	1	—	—	2
32	1	2	—	—	—	—	—	—	3
33	—	1	—	1	1	—	—	—	3
35	—	—	—	1	—	—	—	—	1
38	—	1	—	—	—	—	—	—	1
39	2	—	1	—	—	1	—	—	4
Totals	1,285	1,505	1,502	113	95	16	32	27	4,575

III. PRIMARY AND AUXILIARY HOSPITALS.

It was considered advisable to determine, as far as possible, the relative stay in Primary and Auxiliary Hospitals (Table III). In 218 cases only was the necessary information available, although there was evidence that many more cases were transferred to Auxiliary Hospitals, but the period was not stated. Clearly it is not justifiable to draw conclusions from so small a number of cases, but subject to this reservation we may be permitted to draw attention to the fact that so far as the figures go they indicate a direct parallelism between the length of stay in Primary and Auxiliary Hospitals ; in other words, the longer a patient is retained in a Primary Hospital, the longer will be his subsequent stay in an Auxiliary.

TABLE III.—*Cases Transferred to Auxiliary Hospitals.*

Week during which Discharged.	No. of Cases.	Average Time in Primary.	Average Time in Auxiliary.	Disposal.		
				Fur. I.	Fur. II.	M.C.H.
		Days.	Days.			
3	1	6	9	—	1	—
4	3	6	21	2	1	—
5	22	10	22	8	11	3
6	28	29	14	4	19	5
7	24	20	27	7	13	4
8	29	28	26	6	19	4
9	39	34	34	11	25	3
10	21	17	49	8	12	1
11	17	26	48	3	14	—
12	19	33	47	4	15	—
13	4	21	66	1	3	—
14	1	62	31	—	—	1
15	3	37	64	2	1	—
16	2	47	64	—	1	1
Over 18	5	109	53	1	3	1
Total ...	218	—	—	57	138	23

IV. PROLONGED STAY IN HOSPITAL.

In Table IV there are found the principal conditions which prolong the stay in hospital over nine weeks. The cases which fall into this class number 787, or 17·2 per cent. The chief causes are seen to be four : namely, Disordered Action of the Heart, Photophobia, Bronchitis, and Aphonia. In yet another 90 cases one or other of these symptoms was the cause of the prolonged stay, but it was not clearly stated which. Unfortunately in 175 cases no cause was given for prolonged retention.

TABLE IV.—*Symptoms prolonging Stay in Hospital over Nine Weeks.*

Week.	D.A.H.	Bronchitis.	Laryngitis.	Photophobia.	Hæmoptysis.	Broncho-pneumonia.	Gastritis.	Burns.	Diarrhœa.	Cough.	Conjunctivitis, Laryngitis and Bronchitis.	Other Diseases.	Unknown.	Total.
10th	30	33	38	52	—	4	3	15	—	—	31	11	37	254
11th	28	28	18	33	—	1	9	8	—	—	10	12	19	166
12th	14	18	11	16	—	—	5	4	—	3	33	15	14	133
13th	14	10	8	12	—	—	3	2	1	2	11	3	—	66
14th	11	7	5	6	—	—	2	2	—	2	4	4	1	44
15th	2	3	9	—	—	1	2	4	—	—	—	3	1	25
16th	5	2	6	2	—	—	3	1	—	—	1	2	1	23
17th	1	1	2	1	—	—	1	—	—	—	—	2	—	8
18th	1	3	—	1	—	—	2	—	—	1	—	2	—	10
19th	3	2	3	—	—	—	—	—	—	—	—	—	—	8
20th	—	1	—	1	—	—	—	1	—	—	—	—	—	3
21st	1	—	—	2	—	—	—	—	—	—	—	2	—	5
22nd	—	—	1	1	—	—	—	—	—	—	—	—	—	2
23rd	—	1	1	1	—	—	—	—	—	—	—	—	1	4
24th	1	1	2	—	—	—	1	—	—	—	—	1	—	6
25th	—	1	1	1	—	—	—	—	—	—	—	—	—	3
26th	—	1	—	2	1	1	—	—	—	—	—	1	—	6
27th	—	—	—	—	—	1	2	—	—	—	—	—	—	3
29th	2	—	—	—	—	—	—	1	—	—	—	—	—	3
30th	1	1	—	—	—	—	—	—	—	—	—	—	—	2
31st	—	1	1	—	—	—	—	—	—	—	—	—	—	2
32nd	—	2	—	—	—	—	1	—	—	—	—	—	—	3
33rd	—	1	—	—	—	—	1	—	—	—	—	—	—	2
35th	—	—	1	—	—	—	—	—	—	—	—	—	—	1
38th	1	—	—	—	—	—	—	—	—	—	—	—	—	1
39th	1	1	—	—	—	—	—	1	—	—	—	1	—	4
	116	118	107	131	1	8	35	39	1	8	90	59	75	787

V. REDUCTION IN CATEGORY.

The conditions resulting from Gas Poisoning which necessitated the reduction of cases from Class " A " to a lower category were investigated. Unfortunately, information which would have led to a definite opinion being formed was scanty. Out of 70 cases (1·5 per cent. of the whole) which were reduced in Category, in only 39 cases was any definite reason given to indicate why such a reduction was necessary (Table V). It is felt that results obtained in this section are very inconclusive, but are indicative of the importance of certain after-effects of Gas Poisoning.

TABLE V.—*Causes of Classification: "III. Employments."*

Gas Sequelæ.	Cases.	Other than Gas Conditions.	Cases.
Vomiting	4	Deafness	6
Photophobia	8	Appendicitis	1
D.A.H.	15	Nephritis	1
Bronchitis	10	Bronchitis	1
Burns	2	? Pulmonary Tuberculosis	1
Not stated	31	Defective Eyesight	1
		G.S.W.	1
		Neurasthenia and Debility	6
		Incontinence of Urine	1
		Varicose Veins	1
		Already in "B" Category	5
Total	70	Total	25

VI. PERMANENTLY UNFIT.

The causes of discharging cases of Gas Poisoning from the Army as Permanently Unfit for further Military Service are found in Table VI. In all the 4,575 cases only 16, or 0·33 per cent., were so disposed of. It must be remembered, however, that when those discharged from the Service after re-admission to hospital are taken into account, the total is brought to about 0·5 per cent.

TABLE VI.—*Causes of Discharge from the Army as Permanently Unfit.*

Gas Sequelæ.	Cases.	Other Diseases.	Cases.
D.A.H.	5	G.S.W. Hand	1
Bronchitis	3	Deafness	2
Recurrent eczema	1	Raynaud's disease	1
Gastric symptoms	1	Pulmonary tuberculosis	1
Not stated	1		
Total	11	Total	5

VII. DEATHS.

Table VII shows the causes of Death. The total number of deaths was 32 (0·7 per cent. of the whole).

In 30 cases the cause of death was ascertained, and it appears that the preponderating cause of death was Broncho-pneumonia, which accounts for more than two thirds of the deaths the cause of which is known. In three cases the broncho-pneumonia was complicated by empyæma.

TABLE VII.—*Causes of Death.*

Cause of Death :		Cases
	Broncho-pneumonia	24
	Cholecystitis	1
	Septicæmia	1
	Toxic absorption from burns	3
	Cardiac failure	1
	No evidence available	2
	Total	32

Another striking fact which is not shown in the table is the number of cases in which the patient was apparently making satisfactory progress when sudden collapse and death supervened. This occurred in 10 of the 32 cases, and in six of these the notes draw special attention to the occurrence of acute dyspnœa and cyanosis without corresponding signs in the lungs.

All the deaths were directly attributable to the effects of the Gas. In five cases post-mortem examinations were made. The full notes of the findings are appended.

CASE 1. PTE. S.

Mustard Gas Shell Burns, Face, Arms and Chest, 1.5.18.

Admitted 7.5.18, very ill. Erythema and some vesication of face. Conjunctivitis both eyes. Right arm vesication on inner surface above elbow. Left arm vesication at fold of elbow. Neck, vesication. Vesication on back, shoulders, and buttocks. Laryngitis, some bronchitis. Blood-stained sputum.

8.5.18. Right cornea seems clear. Lower half of left cornea seems hazy.

9.5.18. Heart sounds very indifferent. Pulse 150, respirations 30. Few moist sounds both bases. General condition very bad, pulse rapid and weak.

10.5.18. The patient's condition rapidly became worse during the night, and he died at 8.15 a.m.

Post-mortem Examination.

Head. Dura adherent to bony cranial vault. Otherwise brain and membranes normal.

Chest. Larynx and trachea markedly congested, but no ulceration. Right lung recent pleurisy with some lymph. A few small hæmorrhagic patches on surface. Both lungs are generally emphysematous, and show pulmonary hæmorrhages in lower lobes, more marked in right lung. Obsolete tubercle at right apex, and some congestion around heart. A few sub-pericardial petechiæ over posterior surface.

Liver. Fatty and friable.

Kidneys. Congested.

Other Organs. Normal.

CASE 2. GNR. S.

Gassed, Shell.

Admitted 29.6.18. Patient 21 years old, well-developed, muscular, and well-nourished. Gas burns of varying degrees over head and neck. Gas burns of second degree on both shoulders. Burns of second and third degrees involving arms, forearms, and wrists. Extensive gas burns on back, of second degree, extending from the nape of the neck to the crest of the ilium and mid-axillary line on both sides. Penis and scrotum second degree burns.

Physical Examination. Hearing normal. Eyelids inflamed and red. Purulent conjunctivitis, lachrymation and marked photophobia present. Mouth : tongue coated, teeth clean, throat inflamed. Chest, expansion full and equal. Percussion resonant, with a slight increase of dulness at both bases. Breath sounds, vesicular-vocal fremitus slightly increased at both bases. Heart sounds were rapid but regular, and no murmurs heard. Abdomen, no tenderness nor rigidity. G.U. system, micturition painful owing to gas burns on penis. Urine normal.

1.7.18. Respirations 28, pulse 120. Condition worse. Complains of great thirst. Involuntary passage of fæces into the bed. Patient died 12.30 a.m. 2.7.18.

Post-mortem Examination.

Body is that of well-developed male. Apparent age 23. Rigor mortis present. Post-mortem suggilation in dependent parts of the body.

The body is very extensively burned with gas, the degree of the burns varying from the first to the third. On the back, a burn of the second and third degree extends from the nape of the neck to the iliac crests. Laterally, the area extends to the anterior axillary line on the right side and the mid-axillary line on the left side. The skin of the right arm is burned to the second and third degree from the shoulder to the wrist, whilst on the left the process is fairly well limited to the upper arm. Numerous small burns are irregularly distributed on the anterior surface of the trunk. The penis and scrotum are burned to the second and third degree. The conjunctivæ show extensive ecchymosis and some œdema. The eyes present the appearance of exophthalmos.

Viscera :

Pericardium, found to contain a small amount of clear fluid.

Heart, weight 11 ounces. The left ventricle is firm and contracted. The right ventricle is soft and relaxed. The visceral pericardium presents numerous areas of petechial hæmorrhages, which, for the most part, are limited to the posterior surface of the heart. The cardiac chambers all contain a certain amount of goose-fat clot, otherwise show nothing abnormal. Slight atheroma in its earliest stage is present at the aortic base and about the openings of the coronary arteries. The coronary arteries show nothing abnormal. The myocardium seems fairly firm and normal in appearance.

Pleural Cavities and Lungs. Lungs completely fill the pleural cavities. There are a few fairly firm adhesions at the left base. More numerous and more firmly organised adhesions are present at the right base, especially posteriorly the breaking down of which causes some laceration of the pulmonary tissue, Both lungs present a somewhat similar appearance.

Left lung. Weight 24 ounces. The surface is smooth and shiny, except where it is roughened by the tags of broken down adhesions. The upper lobe is crepitant throughout, air-holding, and quite red in colour. The lower lobe is extremely reddened and congested and is quite mottled in appearance. On section, the upper lobe is brightly red, showing an active congestion with a certain amount of œdema. There are numerous granular areas, peribronchial, where the lung tissue is firmer in consistency and quite hard. These areas stand out from the remaining surrounding portions of the lung. The colour of these areas is darker than the rest of the lung. The lower lobe presents a similar condition, only to a more advanced degree, with a super-added hypostatic congestion and œdema. The lower portion of the lobe is very red, and sections sink in water.

Right lung. Weight 22 ounces. Similar to the left.

Bronchi. The mucosa shows intense congestion and œdema, with an organised exudate, resembling casts, which lies within the lumen, and is readily detached from the walls.

Abdomen. Spleen, slightly enlarged, capsule smooth, on section surface is somewhat mottled in appearance and congested.

Suprarenals. Nothing abnormal macroscopically.

Kidneys. Left, enlarged, smooth, capsule strips readily. The cortex is somewhat thickened, and the cortical vessels appear quite distinctly, with paler intervening areas. The medullary rays are well differentiated from the cortex. The right kidney is similar to the left.

Gastro-intestinal Tract. Stomach, numerous areas of submucous congestion. Duodenum, numerous areas of petechial hæmorrhage beneath the mucosa. Such areas are also present in the jejunum and ileum. Colon and rectum, nothing abnormal.

Liver, shows very little change, slight passive congestion.
Gall-bladder, contains a small amount of thin green bile.
Pancreas, nothing abnormal.
Abdominal aorta, nothing abnormal.
Receptaculum chyli, thoracic duct, nothing abnormal.

Histological Examination of the Tissues.

Heart. Some segmentation and fragmentation cordis. Striations fairly distinct. The nuclei stain quite deeply. There is a small amount of round-celled infiltration and some congestion of the vessels and capillaries. The endothelial cells lining the vessels appear round and swollen. The individual bundles seem separated by larger spaces than normal, and in these there is a granular material in the connective tissue matrix.

Suprarenals. Are quite congested. The cells of the zona glomerulosa stain quite deeply, the round nuclei being clearly defined. In the zona fasiculata the cells appear smaller and stain with much less detail. Here the columns of cells are separated by wide areas, in which strands of connective tissue are present.

Kidneys. Definite vascular congestion; most marked in the medullary portion of the organ, where the capillaries, too, are distended with red cells. No definite thickening of the vascular coats.

Glomeruli: markedly congested. Nuclei stain deeply and clearly. Cells of Bowman's capsule are swollen, in some instances have desquamated and, along with granular material, are free in the glomerular spaces. There is no definite thickening of the capsular wall, which appears thicker than normal, on account of the swollen elements. In some cases the glomeruli have contracted away from the capsule. These are quite congested, and in the larger spaces a considerable amount of granular material and a few cells are found.

Convoluted tubules: The cells are swollen, pale and granular; with nuclei less distinctly staining than in other portions of the kidney. The lumen contains a certain amount of granular detritus. In some areas the epithelial lining has completely desquamated.

Collecting tubules: Much less involved, the cellular detail is quite distinct, both nuclei and cytoplasm staining more clearly than in the convoluted tubules. The inter-tubular vessels, however, are markedly congested. A certain amount of granular detritus is present in the lumen of these tubules.

Pancreas. There is a very definite congestion of the interacinar vessels. The cells appear somewhat smaller and quite granular.

Lungs. The lungs show a very intense congestion. The alveolar vessels are gorged with blood, giving the appearance of much thicker walls. The epithelial cells lining the alveoli are swollen, and in numerous instances have desquamated, lying amidst the alveolar exudate. The nature of this exudate varies. In the air-holding portion of the lungs, the exudate is not very abundant, and is composed of numerous red cells, with a few epithelial cells, and polymorphonuclear leucocytes.

In the consolidated granular areas, there is most intense congestion, with excessive extravasation of red cells into the alveolar space. In some spaces the red cells predominate in the exudate, whilst in others the infiltrating polymorphonuclear cells are present in greater number. Fibrin is present in certain alveoli, and when present it is usually there in considerable quantities; but its distribution is not very extensive. In two adjacent alveoli one may have fibrin and the other none at all.

CASE 3. SGT. McA.

Admitted 2.5.18. Shell gas poisoning, hyperpyrexia, severe laryngeal symptoms, some broncho-pneumonia.

Post-mortem Examination.

Body well-developed and muscular. Rigidity well marked. Extreme lividity of neck, ears, and posterior parts. Burn of anterior part of skin of scrotum, the skin forming a slough, which was about to separate. No other burns visible. Blood markedly frothy. Some excess of blood-stained fluid in both pleural sacs and in pericardial sac.

Well-marked venous congestion of *pharynx* as far down as the commencement of the œsophagus, of tonsils, uvula, and soft palate, and of aryteno-epiglottic folds. All this area was of a very dark purple colour, but without exudate.

Posterior surface of *epiglottis, larynx, and trachea,* showed similar deep purple colouring, but in addition there was a distinct fibrinous exudate covering these surfaces.

Œsophagus shows no such change.

Bronchi also show intense congestion and contain a frothy blood-stained fluid in large amount.

Both lungs show intense congestion and œdema. The lower lobe of the right lung has a deep purple colour and a shiny appearance. It is almost completely solid, but exudes blood-stained fluid on pressure.

The lower lobe of the left lung does not show such an intensely red appearance. Scattered solid areas can be felt, but these appear to be largely œdematous.

There were some old adhesions over the posterior part of the right lung.

Heart somewhat enlarged, right side dilated. Muscles somewhat pale and soft. Valves healthy, although they show red post-mortem staining. Aorta healthy.

Spleen slightly enlarged, pale, but fairly firm.

Liver uniformly pale, soft, and friable.

Kidneys are slightly enlarged. The cortex is pale and swollen, the medulla deeply congested. The capsule strips easily and leaves a smooth surface.

Stomach shows some irregular congestion, but no hæmorrhage.

Intestine shows nothing of note.

Summary.

Acute pharyngitis, laryngitis, tracheitis, and bronchitis. Œdema, congestion, and early broncho-pneumonia of lung. Toxic changes in the organs.

CASE 4. SGT. D.

Gassed, Shell, 8.4.18.

Admitted 13.4.18, a stretcher case, marked conjunctivitis and dyspnœa. Some laryngitis with hoarseness of voice and soreness of throat.

Temperature 100, pulse 92, respirations 40.

Frequent cough with purulent blood-streaked sputum. Superficial gas burns on scrotum and inner surface of thighs with pigmentation. Some pigmentation of other parts of body resulting from exposure to gas.

Examination of Chest. Shows scattered coarse and fine moist râles all over chest, but especially lower lobes. Breath sounds diminished at bases with note impaired. Upper front note slightly hyper-resonant, with breath sounds harsh. Area of cardiac dulness encroached upon. Heart sounds clear. Colour good.

15.4.18. Sputum : Pus cells and alveolar epith. No organism seen. Oxygen inhalation every second hour with atropine grs. 1/100, every four hours for four doses.

16.4.18. Note dull left lower lobe back and side. Tubular breathing over this area, with moisture after cough, note as on previous examination at right base. Sputum : Pus cells, blood, alveolar epith. and pneumococci. Breath sounds clear. White blood cells 18,000.

25.4.18. Patient much worse this morning. Temperature 102·2, pulse 120 to 140, respirations 40. Friction rub anteriorly over both lower lobes. The purulent sputum tenacious. Upper lobes, front clear and note markedly hyper-resonant, especially on left side, where it is difficult to make out any cardiac dulness. Oxygen for 20 minutes every hour, and brandy drs. 2 every hour. Pulse regular and volume very fair. Patient restless with occasional mental wanderings. The chest in front shows marked tympany over cardiac area, but no displacement as noted by the apex beat. Marked dry friction felt and heard over both axillæ and lower fronts. Behind, marked blowing breathing over both lower lobes and extending into upper. Friction everywhere. The general condition is bad. Respirations 40, pulse 120 but of fair quality.

26.4.18. Patient had great respiratory distress all day yesterday, with pulse increasing in rate and becoming weaker. Oxygen every hour. Brandy every two hours in the afternoon. Strychnine was given, grs. 1/30 per hypo. at intervals. Sputum purulent, and patient gradually becoming weaker. Was unable to cough it up, and died at 12.30 a.m. 26.4.18.

Post-mortem Examination.

Fibrinous pleurisy. Broncho-pneumonia, laryngitis, tracheitis, bronchitis.

Vocal Cords. Loss of epithelium on edges and lower surface.

Trachea. Has a moth-eaten appearance, shows greyish areas with ragged edges with intervening reddish areas over rings of trachea. Spaces between rings of trachea are greyish in appearance.

Bronchi. Mucous membrane of large, medium, and to a lesser extent of the smaller bronchi is congested. The large and medium, and in some parts of lower lobe the finest bronchi, show a similar condition to trachea.

Lungs. Lower lobes: fibrinous pleurisy of both lower lobes. On section, greyish or reddish-grey areas are found about bronchi which are non air-holding, or partially air-holding, and are surrounded by areas of lung which are œdematous, and more reddish areas which are air-holding. Middle lobe: this lobe shows a confluent pneumonia. Upper lobe: shows some emphysema, air-holding throughout, with the exception of posterior portions lower.

Liver and Kidneys. Show evidence of toxæmia.

Brain. Vessels on surface and deeper tissues show evidence of congestion

Smears. Smears from greyish areas of trachea and bronchi show the spirochætal flora of trench mouth, but there are fewer fusiform bacilli. Numerous cocci are found.

Culture. From heart and pericardium shows a streptococcus.

CASE 5. PTE. B.

Gassed (Gas Shell Wound Arm L.), 13.4.18.

Admitted to hospital 2.5.18.

Examination: Complaint, cough, hoarseness, and conjunctivitis. Family History: negative. P.H. negative. Synovitis of left knee 1917, off eight weeks, After gassing blind four days, vomited one day. Now feels better. Coughs at night, eyes watering and dim vision. Slight hoarseness. P.X. Heart and lungs negative.

15.5.18. Pain, tenderness and rigidity in right flank, some dulness at base of right lung behind.

27.5.18. Dulness in right side reaching angle of scapula behind. Chest aspirated, 10 oz. light fluid drawn off. Few pus cells in fluid.

29.5.18. Disease changed. Empyema. Operation resection of 7th and 9th ribs. Lower incision closed, pleural cavity exposed and drained at upper opening.

2.6.18. Aggravating cough, little sputum. Dressing every two hours. Moderate serous exudate from tubes. Lower wound draining. Little pus, but not continuous with pleural cavity. Hot foments and Dakin irrigation every two hours.

5.6.18. Pleural cavity draining now through lower incision. Dakins continued. Complains of right arm being useless because of pain in shoulder.

15.6.18. Temperature does not seem to improve. Eats well, also sleeps well. No complaints.

28.6.18. Condition has been about the same since the 15th. In the p.m. of 29th he suddenly became very exhausted. More pus from side. Severe headache. Vomiting. No pain. Temperature and pulse increased. Growing worse continually.

30.6.18. Died 3 p.m.

Autopsy. Abscess lung above empyema cavity. Lobar pneumonia lower lobe. Other lung normal.

Post-mortem Examination.

Disease: (1) Gas Shell Wound, Arm, Left. (2) Pneumonia.

Right lung: (*a*) Pneumonia lower and middle lobes. (*b*) Abscess of lung, upper lobe. Walled off above empyema cavity. Erosion in 4th intercostal space, but giving no exit to abscess. (*c*) Empyæma cavity well walled off, showing drainage had been excellent.

Left lung: Negative.

Abdominal organs: Negative.

Cause of death: Pneumonia right lung, following abscess.

In Table VIIA are given the chronological data with reference to the fatal cases. The outstanding fact which emerges is the large percentage, 50, of deaths which occur within the first week. Eight deaths even occur within the first 48 hours after landing in the United Kingdom; and the clinical evidence is strong that the condition of these cases was influenced for the worse by too hasty evacuation from France.

TABLE VIIA.—*Chronological Data concerning Fatal Cases.*

Duration of Illness in days.	Date of Gassing.	Date of Transfer to United Kingdom.	Date of Death.	No. of Days in United Kingdom.
4	17.4.18	21.4.18	21.4.18	1
4	19.4.18	22.4.18	23.4.18	1
7	17.4.18	23.4.18	24.4.18	1
8	17.4.18	24.4.18	25.4.18	1
8	7.5.18	14.5.18	15.5.18	1
8	22.4.18	27.4.18	30.4.18	3
8	12.5.18	18.5.18	20.5.18	2
8	10.5.18	13.5.18	18.5.18	5
9	1.5.18	7.5.18	10.5.18	3
9	22.4.18	27.4.18	1.5.18	4
13	10.4.18	18.4.18	23.4.18	5
15	22.5.18	5.6.18	6.6.18	1
17	27.4.18	2.5.18	14.5.18	12
17	22.5.18	30.5.18	8.6.18	9
18	8.4.18	13.4.18	26.4.18	13
20	17.4.18	27.4.18	7.5.18	10
28	10.4.18	21.4.18	8.5.18	19
31	14.5.18	6.6.18	14.6.18	8
33	17.4.18	28.4.18	20.5.18	23
53	11.3.18	16.3.18	3.5.18	48
?	?	29.5.18	9.6.18	11
?	?	6.5.18	13.5.18	7
?	?	17.5.18	27.5.18	10
?	?	25.5.18	11.6.18	17
?	?	1.5.18	19.5.18	18
?	?	2.5.18	8.5.18	6
?	?	2.5.18	29.5.18	27
?	?	13.5.18	15.5.18	2
?	?	29.6.18	2.7.18	3
?	?	19.4.18	22.5.18	33
?	?	4.6.18	6.7.18	32
?	?	29.5.18	1.7.18	34

APPENDIX I.

An analysis has been made of all the gassed cases in a Reserve Depôt. They numbered 450 out of a total strength of 3,225, or 14 per cent. The following points were investigated.

(A) *Duration of Stay in Hospital.*

It was found that the duration of stay of these cases in Primary and Auxiliary Hospitals was practically identical with the figures found in Table II, *i.e.*, approximately six weeks. Similar results to those seen in Table III were obtained in regard to the length of time they were in Auxiliary Hospital in comparison with Primary Hospital (Table A).

(B) *Duration of Convalescence.*

The duration of total stay in Convalescent Hospitals and Command Depôts was found to be on the average about six to eight weeks (Table A).

A comparison was made between the period spent in Primary and Auxiliary Hospitals, and that spent in Convalescent Hospitals or Command Depôts. It was found that a prolonged stay in hospital did not necessarily involve a prolonged convalescence. On the other hand, it was evident that the total period of disability was not influenced by the duration of stay in hospital. In other words, a patient who remained in hospital for one week did not necessarily spend a short time in convalescence, but tended to have a relatively long period ; while on the contrary a patient who remained in hospital for a much longer period tended to have a relatively short convalescence (Table B).

(C) *Total Period of Disability.*

The total period of disability—from the date of gassing to the date of rejoining the Reserve Station—was estimated. The duration of this period varied greatly (Table A). The greatest number were returned to duty between the 10th and 19th weeks. The period of disability is a very considerable one, practically 25 per cent. of the cases taking over 26 weeks to return to duty. It must be borne in mind, however, that the number evacuated to the United Kingdom contain those who are more severely gassed, while the milder cases are retained in France. On the other hand, the cases with which we are dealing are probably the mildest of those which are sent to the United Kingdom, as they have all been returned to their Depôt, presumably fit for full service.

Table A.—*Analysis of Period of Disability.*

Time in Weeks.	Number of Cases.			
	In Hospitals.	In M.C.H.	In Command Depôts.	†Unavailable.
1	14	3	—	—
2	30	9	1	—
3	34	8	3	2
4	41	14	9	3
5	57	9	19	6
6	33	3	46	3
7	39	6	38	11
8	40	2	31	11
9	23	6	37	5
10	19	4	32	20
11	18	2	17	20
12	15	2	17	27
13	8	2	12	24
14	7	1	11	29
15	5	2	8	24
16	2	2	7	15
17	6	1	9	27
18	2	—	2	22
19	6	—	1	21
20	2	—	4	14
21	3	—	4	10
22	2	—	1	17
23	1	—	1	9
24	3	—	1	5
25	1	—	2	8
26	—	—	1	9
27	2	—	3	9
28	1	—	2	8
29	1	—	3	7
30	—	—	1	3
31	—	—	1	4
32	1	—	—	5
33	—	—	—	19
34	—	—	—	9
35	1	—	—	6
36	—	—	—	3
37	—	—	—	9
38	—	—	—	5
39	1	—	—	2
40 to 54	—	—	—	29

† "Unavailable" covers the whole period of disability, from date of gassing to date of return to Reserve Depôt.

TABLE B.—*Comparison between time spent in Primary and Auxiliary Hospitals, and time spent in Military Convalescent Hospitals and Command Depôts.*

Total Period in Hospital, Primary and Auxiliary, in Weeks.	Total Period in M.C.H. and Command Depôt, in Weeks.																	
	1 and 2	3 and 4	5 and 6	7 and 8	9 and 10	11 and 12	13 and 14	15 and 16	17 and 18	19 and 20	21 and 22	23 and 24	25 and 26	27 and 28	29 and 30	31 and 32	33 and 34	35 and 36
1 and 2 ...	2	2	4	4	12	6	2	1	1	—	1	—	—	—	3	—	—	—
3 and 4 ...	1	7	13	22	9	4	2	1	2	1	—	—	—	1	1	—	—	—
5 and 6 ...	2	9	11	16	12	8	4	2	3	—	1	1	1	1	1	—	—	—
7 and 8 ...	3	7	19	13	8	4	3	4	—	1	2	1	—	1	—	—	—	—
9 and 10 ...	—	—	2	8	6	5	1	1	3	—	1	1	—	—	1	—	—	1
11 and 12 ...	2	1	5	—	7	2	2	4	1	2	1	—	—	—	—	—	—	—
13 and 14 ...	—	—	—	1	1	3	1	—	2	—	1	—	—	—	—	—	—	—
15 and 16 ...	—	—	1	1	1	—	1	1	—	—	—	—	—	—	—	—	—	—
17 and 18 ...	—	—	—	—	1	—	1	2	1	—	—	—	1	—	—	—	—	—
19 and 20 ...	—	1	—	—	2	1	1	—	2	1	—	—	—	—	—	—	—	—
21 and 22 ...	—	1	—	1	1	—	—	—	1	—	—	—	—	—	—	—	—	—
23 and 24 ...	—	—	—	1	—	1	2	—	—	—	—	—	—	—	—	—	—	—
25 and 26 ...	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
27 and 28 ...	—	—	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—
29 and 30 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31 and 32 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33 and 34 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
35 and 36 ...	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—

APPENDIX II.

In 67 cases re-admitted to hospitals for symptoms referable to Gas Poisoning, it was found that practically the same symptoms which prolong the original stay in hospital are operative in necessitating re-admission (Table C).

Of these 67 cases 42 eventually returned to duty (Table D); while six (9 per cent.) were discharged as Permanently Unfit. The reasons for such discharge are vomiting, bronchitis, or D.A.H., or combinations of these symptoms (Table E).

TABLE C.—*Symptoms necessitating Re-admission.*

Symptoms necessitating Re-admission.	Chlorine, 4 cases.	Phosgene, 15 cases.	Mustard, 48 cases.
D.A.H.	3	5	11
Bronchitis	2	7	13
Vomiting	2	4	9
Asthma	—	2	—
Neurasthenia	—	2	1
Photophobia	—	—	5
Aphonia	—	—	3
Eczema	—	—	5
Keratitis	—	—	1
Clinical Tuberculosis	—	—	1
Not stated	—	—	3

TABLE D.—*Disposal of Re-admissions.*

Kind of Gas.	No. of Cases.	Disposal.					
		Duty.	M.C.H.	Command Depôts.	P.U.	Transferred.	Reduced in Category.
Chlorine	4	3	—	—	1	—	—
Phosgene	15	11	1	—	2	—	1
Mustard	48	28	7	3	3	6	1
Total	67	42	8	3	6	6	2

TABLE E.—*Symptoms necessitating Discharge as Permanently Unfit.*

Symptoms necessitating Discharge as Permanently Unfit			6 cases
Vomiting	in 2 cases	Bronchitis	in 3 cases
D.A.H.	„ 3 „	Keratitis	„ 1 „

RÉSUMÉ.

In reviewing the preceding analysis and also taking into consideration the findings in the Appendices, the necessity of comparing these figures with similar ones of cases retained in France becomes apparent. According to a letter to the C.W.M.C. from Colonel Elliott, D.S.O., A.M.S., only 10 per cent. of the cases of Gas Poisoning arriving at the Boulogne area were evacuated to England during this period (May, June and July, 1918). The other 90 per cent. were retained in France, and were returned to full duty in from four to six weeks from the time of gassing. According to the description on the cards of the cases which we have received, it is apparent to us that a larger percentage of cases were evacuated from the other hospital areas in France than from the one to which Col. Elliott's letter has reference. This being the case, we have been impressed by the prolonged stay in active treatment hospitals in the United Kingdom of the cases under review. It is true that the high mark of evacuation from such hospitals occurs during the sixth week, which may at first sight be compared with Col. Elliott's maximum date of return to full duty of the less severe cases. But only 14 per cent. of the cases in the United Kingdom return to duty at the end of that period, and to this must be added the 10 days' leave which all overseas casualties are given on discharge from hospital. Further it must be borne in mind that 71·5 per cent. of the cases do not return to duty for a considerable period after they are discharged from the active treatment hospitals. What this extra period may be it was impossible to determine from the cards. But on correlating the statistics of the main group of cases with those of Appendix I, we think a fair indication of the total period of disability of all the cases may be inferred.

In conclusion we wish to draw attention to the fact that the symptoms which cause prolonged stay in hospitals, re-admission to hospital, and those which necessitate reduction in category or discharge from the Service as Permanently Unfit, are broadly the same. There is, however, one exception, namely aphonia, which is a prominent cause of retention in hospital, but is apparently cured, and gives no further serious trouble.

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